INTEGRATING MULTI-STOP SERVICE AND HUB EFFECTS INTO THE ESTIMATION OF THE LONG TERM PRICING IMPACTS OF THE AMERICAN AIRLINES AND US AIRWAYS MERGER

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ABSTRACT

This paper extends recent research into the long term pricing impacts of the American Airlines and US Airways merger in 2013. Zhang and Nozick (2018), using the 10% ticket sample, demonstrated that low cost carriers' post-merger lowered prices for non-stop service post-merger and those reductions in fare were the largest where American Airlines and US Airways were more prominent pre-merger. The paper extends their analysis to include multi-hop service, the impact of hubs and focus cities, and to address the feedback between prices and market concentration by introducing population and income into the statistical models. The estimated models again show that (1) legacy carriers were able to raise prices after the merger and the amount of the increase was larger where American and US Airways played a smaller role in the market pre-merger; and (2) low cost carriers reduced their prices and the amount of the reduction was also heavily influenced by the role that US Airways and American Airlines played in the market pre-merger. For the legacy carriers these trends have generally increased across 2015, 2016 and 2017. For the low cost carriers, the reductions in price over these three years have generally decreased. Finally, we find that where service is provided using airports that are hubs or focus cities, prices are generally higher and that impact is more pronounced in 2016 and 2017 in contrast to 2015.

BIOGRAPHICAL SKETCH

Ziwei Li is a second-year Master of Science student in Transportation System Engineering at Cornell University School of Civil and Environmental Engineering. In 2012, he earned a bachelor's degree in Beijing Jiaotong University and served as student intern at University of Maryland in his junior year. Being passion of statistics, Ziwei has been extensively involved in the field of data mining and machine learning. His research of interest includes optimization of train fuel cost, big data management and application of varies statistic techniques. Other than that, he spends much of his free time in the basketball court and travelling around the country.

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TABLE OF CONTENTS

BIOGRAPHICAL SKETCH..III

ACKNOWLEDGMENTS IV

LIST OF TABLES VI

INTRODUCTION..1

DATA, VARIABLES AND MODELS 2

RESULT 6

CONCLUSIONS..9

REFERENCES..11

LIST OF TABLES

TABLE 1 Base Model……………………………………………………………….6

TABLE 2 Extended Model…………………………………………………………….7

TABLE 3 Change of Fare Relative to 2011………………………...……………….8

INTRODUCTION

There has been a burst of airline mergers in the past three decades caused by the intense competition that has emerged between carriers since the deregulation of the air transportation industry in 1978 [1]. Only four of seven transcontinental legacy carriers in the U.S. remained by the early 2010s as a result of airline restructuring post deregulation. In 2013, the U.S. Department of Justice approved the merger of American Airlines and US Airways creating the world's largest airlines. Merged carriers generally benefit post-merger through increases in operating efficiencies as well as improved market power. While increased efficiency leads to lower marginal costs, prices often rise post-merger because of the reduction in competition and therefore the increased pricing power of the merged carrier.

Many studies have found statistically significant relationships between mergers and airfares. Early research [2] identified fare increases that were shown to be correlated with mergers in the air market from 1985 to1988. Focused on the merger wave between 2009 and 2012, [3] examined the short-term pricing impacts and estimated an overall 2.3% to 5.9% increase in ticket prices. However, as described in [4], each merger has had their distinctive price impacts that are associated with the market characteristics and the level of competition present before and after the merger.

Competitive effects in the airline market have been the subject of many studies. [5] examined the competitive impacts of low-cost carriers on legacy carriers. As shown in [6] and [7], entrance of low-cost carriers is associated with significantly lower airfares. In addition to the association of increased pricing with the presence of actual competitors in the market, the concept of potential competition, defined as carriers that do not serve a specific route but provide air service at either or both endpoints of the route, has been investigated in recent studies with promising results. [7] compared the effect of actual and potential competitors and found they are both associated with a reduction in fares, especially when there is potential competition at both endpoints. [8][9] also showed downward pricing pressure when a low-cost carrier entered the market. [10] showed empirically that potential entrants have a stronger effect in competitive environments in comparison with monopoly markets. [11] empirically demonstrated the substantial impacts of potential competition by low-cost carriers in both nonstop and multi-stop markets.

[12] empirically demonstrates the impact of the US Airways and American Airlines merger on the pricing of non-stop air fares in the United States using the 10% ticket sample made available by the Department of Transportation. They focused their analysis on a comparison of ticket prices in 2011 with prices in 2015 and 2016. They integrate into their analysis the effects of within market actual and potential competition as well as the differing impacts of legacy and low cost carriers as was developed in [13]. They show that the new American Airlines increased fares. They also showed that other legacy carriers were also able to increase fares and that these increases where the higher

when US airways and American had a smaller presence pre-merger. In contrast low cost carriers generally reduced prices post-merger and these reductions were the largest when American and US airways played a larger role pre-merger.

We extend that analysis to consider multi-stop service as well as the impact of hubs and focus cities on carrier pricing. [12] did include the Herfindahl–Hirschman Index (HHI) as a measure of market concentration. Since there may be a feedback effect between pricing market concentration [13] we include population and income as an aid in resolving the impacts of this feedback. These same variables have also been shown to be useful in [4]- [10]. We also extend the pricing comparison to 2017.

Next section describes the data used in the modeling and analysis. Based on that data, the next section describes the variables considered and the resultant models developed. The third section provides and analyzes the insights generated by the models. The final section offers conclusions and directions for future research.

DATA, VARIABLES AND MODELS

Following the previous studies, we use the Airline Origin and Destination Survey (DB1B) from the U.S. Department of Transportation as data source for market-based pricing information. DB1B is a quarterly based dataset that is a ten percent sample of virtually all airline tickets with information about each OD pair in the air market. We focus on the calendar year 2011, which is prior to the American Airlines-US Airways merger, and three consecutive years' post-merger (2015, 2016, 2017) for analysis. As of this writing the fourth quarter of 2017 is not available hence for 2017 our focus is on the first three quarters. We use three years' post-merger in an effort to understand what short terms pricing impacts are and what longer terms pricing impacts are.

We consider both roundtrip and one-way tickets that cost between \$10 and \$2,000. These restrictions are the same as in [12] [14]. [15] uses a lower bound price of \$25. Roundtrip tickets in the dataset are treated as two separated one-way tickets. We explicitly consider four legacy carriers and seven low cost carriers. The legacy carriers are American Airlines, US Airways, Delta and United. The low cost carriers considered are Jet Blue, Frontier, Southwest, Spirit, Allegiant, Sun Country and Virgin Airlines. These are the same carriers considered in [12]. We include all airports in the United States that provide service from at least one of the 11 carriers considered. This is about 400 airports. In 2011, American, US Airways, United, and Delta served 25,562, 24,554, 38,351, 46,216 markets, respectively. Across the seven low cost carriers another 12,652 markets were served that year. By 2017 the new American Airlines, United, and Delta served 46,888, 35,808 and 42,089 markets in the centennial United States. 13,884 markets had service from at least one of the seven low cost carriers.

As in [12] we measure market concentration using the Herfindahl-Hirschman Index (HHI) and whether or not an airport at one or both ends of a market are slot constrained. HHI is a well-accepted measure that explicitly considers the distribution in the size of the competitors in a market. We extend the analysis in [12] by including one stop and multi-stop service in addition to nonstop service.

The use of an airport as a hub or a focus city within a carrier's network can influence airfares at that airport. As argued in [16], dominant carriers at hub airports may have more freedom in setting fare with advantages such as building connection with local industry/government and travel agencies. Also, by offering frequent flyer programs or other attractive plans, passengers are more likely to be willing to pay more to receive their services. [17] represented hub effects through the specification of a binary variable. If either endpoint on a route was a hub airport the variable took on a value of one, otherwise it was zero. [11] measured service concentration by a carrier providing service in a market by calculating the weighted average of that carrier's passenger shares at the market's two endpoints. We develop a related measure to characterize the degree to which a carrier is using an airport as a hub. For each carrier and airport, we compute the percentage of their passengers that transfer flights at an airport (in contrast to their using that airport as an origination or destination). For each carrier and itinerary, we average these percentages across all airports used.

As noted in other studies, airfare is impacted by demographic and socioeconomic conditions around the airports that define the market (e.g. [11] and [16]). Generally, a larger population and higher incomes leads to increased demand for passenger air travel. However, higher densities of passengers originating or terminating at an airport can lead to cost savings allowing for reductions in fares [11]. To measure population, we use population in the metropolitan statistical area (MSA) where the airport is located [19]. For each market, we use the logarithm of the product of the population at the market endpoints.

Others have used related measures for population. For example, [3] used the product of the population of the originating and terminating airports, [17] took the square root of the product of the populations. [10] and [14] used the sum of the populations at the originating and terminating airports. For income, we use per capita income at the market's origin city; which is consistent with [16].

We explicitly consider whether US Airways and or American Airlines was an incumbent or potential entrant in each market prior to the merger using the variables developed in [14] and used in [12]. An incumbent carrier provides service in the market. A potential competitor provides service at one or both endpoint airports of the market but does not provide service in the market. This leads to six situations that are possible with a focus on American Airlines and US Airways pre-merger. As in [14], we denote the six variables as two-zero, one-one, zero-one, one-zero, zero-two and zero-zero. The first number represents whether US Airways and/or American are incumbents followed by whether US Airways and/or American Airlines are potential entrants. For example, two-zero denotes a market served by both American Airlines and US Airways (and therefore neither are potential entrants). Zero-two stands for a market with neither US

Airways nor American Airlines pre-merger providing service but both carriers operating at one or both airports that are the endpoints of the market.

The model using OLS, without considering the roles US Airways and American Airlines played pre-merger, is as given in Equation (1) below.

$$ln(fare_{ijt}) = \beta_0 + \beta_1 \ln(Dist_{ij}) + \beta_2 \ln(HHI_{ijt}) + \beta_3 Slots_{ij} + \beta_4 Post + \beta_5 OLeg + \beta_6 LCC + \beta_7 Q_2 + \beta_8 Q_3 + \beta_9 Q_4 + \beta_{10} OLeg * Post + \beta_{11} LCC * Post + \beta_{12} OneStop + \beta_{13} MultiStop + \beta_{14} PassPct + \beta_{15} Pop + \beta_{16} Income \tag{1}$$

where i, j denotes the airports that are the origin and destination of the market, t is the time period (year and quarter); $fare_{ijt}$ is the airfare form from origin airport i to destination airport j in time t; $Dist_{ij}$ is the distance from airport i to destination airport j. HHI_{ijt} is the Herfindahl–Hirschman Index for all carriers that provide service from airport i to airport j in time t; $Slots_{ij}$ represent is a binary variable that takes on a value of one if either airport i or airport j or both are slot constrained and is zero otherwise. $Post$ is a binary variable that takes on the value of one if the observation occurs after the merger and is zero otherwise; $OLeg$ is a binary variable that takes on a value of one if the carrier is one of the two other legacy carriers (Delta Airlines and United Airlines) and is zero otherwise; LCC is a binary variable that equals one if the carrier is one of the seven low cost carriers and is zero otherwise; Q_2, Q_3, and Q_4 are each binary indicator variable for the quarter of the year the observation is from and are zero otherwise; $OneStop$ is a binary variable that is one if the route that is used to service on in the market has one intermediate stop. $MultiStop$ is a binary variable that takes on the value of one when the route has more two or more stops; $PassPct$ is the average number of passengers that transfer flights across all airports in the passenger's literary for their carrier; Pop is the log of product of the populations at the cities at the end of the market; Income is the per capita income in the city that is the origin for the market. It is important to notice that the impacts of one stop and more than one stop service are evaluated in comparison to non-stop service.

The base model is then extended in Equation (2) to measure competition effects as follows:

$$\begin{aligned} ln(fare_{ijt}) = {} & \beta_0 + \beta_1 \ln(Dist_{ij}) + \beta_2 \ln(HHI_{ijt}) + \beta_3 Slots_{ij} + \beta_4 Post + \beta_5 OLeg \\ & + \beta_6 LCC + \beta_7 Q_2 + \beta_8 Q_3 + \beta_9 Q_4 + \beta_{10} OLeg * Post + \beta_{11} LCC * Post \\ & + \beta_{12} OneStop + \beta_{13} MultiStop + \beta_{14} PassPct + \beta_{15} Pop \\ & + \beta_{16} Income + \beta_{17} Pot_{ijt} + \beta_{18} INC2POT0_{ijt} + \beta_{19} INC1POT1_{ijt} \\ & + \beta_{20} INC0POT2_{ijt} + \beta_{21} INC2POT0_{ijt} * POST * OLeg \\ & + \beta_{22} INC1POT1_{ijt} * POST * OLeg + \beta_{23} INC0POT2_{ijt} * POST \\ & * OLeg + \beta_{24} INC2POT0_{ijt} * POST * LCC + \beta_{25} INC1POT1_{ijt} \\ & * POST * LCC + \beta_{26} INC0POT2_{ijt} * POST * LCC \end{aligned}$$

(2)

where Pot_{ijt} is the number of potential competitors, defined by the number of carriers that provide service at airport i and/or airport j as during time t but do not provide service from airport i to airport j. $INCmPOTn_{ijt}$ are dummy variables focused on the role of US Airways and American Airlines pre-merger. They take on a value of one if there are *m* incumbents and *n* potential entrants from airport i to airport j during time *t*. While there are 6 variables for each time period of this structure, we only use four of them in these models. There are effectively no markets that fit the description of $INC1POT0_{ijt}$ and $INC0POT1_{ijt}$, hence they are discarded.

RESULT

The base model and the extended model are fitted using market data in 2011 combined with either market data from 2015, 2016, or 2017. The estimated coefficients for the base models are provided in Table 1. The results for extended model are given in Table 2. Coefficients in both baseline and extended models are all highly significant, and are consistent over the three years considered post-merger. Coefficients in the base model are also consistent with those in the extended model.

Table 1: Base Model

Variable	*Year 11-15*	*Year 11-16*	*Year 11-17*
Intercept	3.49***	2.97***	3.00***
$ln(Dist_{ij})$	0.299***	0.328***	0.328***
$ln(HHI_{ijt})$	0.0326***	0.0512***	0.059***
$Slots_{ij}$	0.045***	0.030***	0.031***
$Post$	0.047***	0.065***	0.075***
$OLeg$	-0.061***	-0.063***	-0.064***
LCC	-0.199***	-0.183***	-0.182***
$OLeg * Post$	0.082***	0.074***	0.104***
$LCC * Post$	-0.194***	-0.118***	-0.121***
Q_2	0.019***	0.012***	0.045***
Q_3	4.2e^{-4}	9.7e^{-3}***	0.01***
Q_4	-0.016***	8.0e^{-3}***	0.013***
OneStop	0.389***	0.515***	0.505***
Multi-Stop	0.544***	0.63***	0.621***
passPct (mean)	0.036***	0.144***	0.151***
Population (log product)	-0.019***	-0.012***	-0.013***
income	-9.3e^{-7}***	-5.7e^{-7}***	-5.2e^{-7}***
Adjusted R^2	0.2674	0.2726	0.2872

(*,**,***significant at .01, .001 and .0001, respectively)

Table 2: Extended Model

Variables	*Year 11-15*	*Year 11-16*	*Year 11-17*
Intercept	3.34***	2.88***	2.92***
$ln(Dist_{ij})$	0.307***	0.332***	0.332***
$ln(HHI_{ijt})$	0.025***	0.048***	0.056***
$Slots_{ij}$	0.051***	0.035***	0.037***
$Post$	0.042***	0.062***	0.066***
$OLeg$	-0.058***	-0.060***	-0.060***
LCC	-0.19***	-0.179***	-0.177***
$OLeg * Post$	0.087***	0.080***	0.104***
$LCC * Post$	-0.216***	-0.148***	-0.121***
Q_2	0.019***	0.013***	0.045***
Q_3	-3.5e^{-3}***	0.010***	0.010***
Q_4	-0.02***	8.4e^{-3}***	0.015***
OneStop	0.378***	0.510***	0.501***
MultiStop	0.531***	0.625***	0.618***
passPct (mean)	0.035***	0.137***	0.144***
Population (log product)	-0.015***	-9.7e^{-3}***	-0.011***
income	-9.1e^{-7}***	-5.3e^{-7}***	-5.0e^{-7}***
Pot_{ijt}	-0.013***	-8.3e^{-3}***	-8.8e^{-3}***
$INC2POT0_{ijt}$	0.075***	0.053***	0.058***
$INC1POT1_{ijt}$	0.093***	0.058***	0.059***
$INC0POT2_{ijt}$	0.055***	0.020***	0.018***
$INC2POT0_{ijt} * POST * OLeg$	-0.031***	-0.038***	-0.061***
$INC1POT1_{ijt} * POST * OLeg$	-0.014***	-0.015***	-0.018***
$INC0POT2_{ijt} * POST * OLeg$	0.061***	0.059***	0.052***
$INC2POT0_{ijt} * POST * LCC$	0.048***	0.023***	-0.011***
$INC1POT1_{ijt} * POST * LCC$	0.051***	0.097***	0.070***
$INC0POT2_{ijt} * POST * LCC$	0.050***	0.095***	0.104***
Adjusted R^2	0.2698	0.2744	0.2817

(*, **, *** significant at .01, .001 and .0001, respectively)

In the base models and consist with previous studies, the models show that airfare generally rises with distance, HHI, number of stops, and slot constraints. They also show that fares rose post-merger. A higher HHI indicates less competition and the model suggests that this is associated with higher fares. The model coefficients imply that a 1% increase in HHI is associated with a 3-6% increase in fares.

Also consistent with past studies, airports that operate under slot constraints have fares that average about 3-5% higher. The coefficient for $Post$ provides empirical evidence to suggest that the merger is associated with rising airfares. The fare increases were about 5% higher in 2015 and about 8% 2017 (in comparison to 2011). Regarding the impact of hubs, as approximated by the independent variable passPct, empirically they are associated with a positive effect on prices and that impact has risen over the three-year period. It is interesting to note that the coefficients for this variable are substantially higher for 2016 and 2017 in comparison to 2015. In 2015 a 1% increase in passPct was associated with about a 4% increase in fares. By 2016 that increase was on the order of 15%. This is likely attributable US Airways and American being in the concluding stages of the merger hence their operations were not exactly separate or joined.

Population and income coefficients are negatively correlated with airfares as has been observed in other studies [3] [5]. This implies that generally the efficiency gains that come with greater air travel offsets the opportunity to raise fares on more economically advantaged travelers. Generally, the quarterly indicator variables show an upward trend across three years. Likely this reflects cost increases in the airline industry [20]. Finally, each additional potential entrant dampens ticket prices by about 1%.

The pricing impacts on the two other legacy carriers and low-cost carriers by the American Airlines and US Airways merger are examined by considering the airfare changes derived from the extended regression model. Table 3 gives estimated percentage change in price for three years after the merger based on the roles that American Airlines and US Airways play in the market pre-merger.

Table 3: Change in Fares Relative to 2011

Carrier Group	2015	2016	2017
Merged Carrier (AA)	4.29%	6.40%	6.82%
United/Delta w/o AA/USAir in Mkt	13.77%	15.26%	26.62%
United/Delta with (2,0)	10.30%	10.96%	11.52%
United/Delta with (1,1)	12.19%	13.54%	16.42%
United/Delta with (0,2)	20.92%	22.26%	24.86%
LCC w/o AA/USAir	-15.97%	-8.24%	-5.35%
LCC with (2,0)	-11.84%	-6.11%	-6.39%
LCC with (1,1)	-11.57%	-1.11%	-1.51%
LCC with (0,2)	-11.66%	0.90%	5.02%

(incumbent, potential entrant)

On routes without American Airlines or US Airway in the market pre-merger, Delta and United generally increased airfares over the three years; about 14% in 2015 to nearly 27% in 2017 compare with 2011. Notice these increases are substantially higher than for the merged carrier.

However, this pricing behavior was not shared by the low-cost carriers in the same situations. Their fares dropped about 16% in 2015 compare with 2011. This drop was reduced to about 6% in 2017.

When American Airlines and US Airway played a role as either an incumbent or a potential entrant in the market, other legacy carriers still increased prices but those increases where not as dramatic as when they were not present. Specifically, taking year 2015 as example, when both American Airlines and US Airways are incumbents, the prices increased by about 10% post-merger compare with 2011. In comparison, ticket prices increased about twice as much if both carriers were potential entrants. These increases in fares persisted and have become larger over the three years from 2015 to 2017. As in [12] it is clear that on routes with US Airways and American Airlines as incumbents' pre-merger, price increases on the part of Delta and United that are correlated with the merger are lower than when the carriers were potential entrants. Further, fare increases were more dramatic on the part of these legacy carriers when US Airways and American were neither incumbents nor potential entrants' pre-merger.

The behavior of low cost carrier's post-merger is substantially different than for Delta and United. When American Airlines and US Airways are both incumbents in the market, low-cost carriers reduced prices by 12% and 6% in 2015 and 2017, respectively in comparison to 2011. When American Airlines and US Airways were potential entrants, the price reductions for low cost carriers were about 12% 2015. This decrease did not persist over the three years and by 2017, low cost carrier where US Airways and American Airlines were potential entrants' pre-merger had increased prices by almost 5% in comparison with 2011.

CONCLUSIONS

Similar to other studies, this paper demonstrates that fares tend to be higher in markets with lower levels of competition (as measured by HHI), use of airports with slot constraints, and where the airports used serve a "hub" like role in the carrier's network. Fares tend to be lower in markets with larger populations and higher incomes.

Consist with the previous studies, this analysis also shows that, the American Airlines and US Airways merger was are associated with increases in fares. However, this positive association was confined to the merged carrier as well as legacy carriers with the magnitude of the increase governed by the role that US Airways and American Airlines played pre-merger. For low cost carriers, however there was a decline in prices with the magnitude of that decline also governed by the role of US Airways and American Airlines pre-merger. Over time the decline in prices for the low cost carriers has become smaller and the increase in prices for the merged American Airlines, Delta and United has generally not only been sustained but has risen higher.

Our analysis focuses solely on potential competition between legacy and low-cost carriers for routes that serve one or both endpoints but do not serve the route itself. As demonstrated in [11], adjacent routes also can have significant impact on pricing by acting as a substitute for customers. Thus, it is useful to add adjacent airports into the measurement of competition. Moreover, studies have suggested a relationship between merger and service quality [3]. Enhanced airline service may lead to improved customer satisfaction that directly relates to ticket pricing. Examining this by including level of service explicitly into the model is another valuable path worth exploring.

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